

CONFIDENTIAL

CENTRAL INTELLIGENCE AGENCY
INFORMATION REPORT

25X1

COUNTRY USSR

SUBJECT Comments and Evaluations on Articles on Chromizing,
Hard Surfacing and Subzero Treatment of Steel

25X1

DATE DISTR. 27 July 1954

NO. OF PAGES 4

NO. OF ENCLS.

SUPP. TO
REPORT NO.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE
OF THE UNITED STATES. WITH THE MEANING OF TITLE 18, SECTIONS 793
AND 794, OF THE U.S. CODE, AS AMENDED, ITS TRANSMISSION OR REVEL-
ATION OF ITS CONTENTS TO OR RECEIPT BY AN UNAUTHORIZED PERSON IS
PROHIBITED BY LAW. THE REPRODUCTION OF THIS REPORT IS PROHIBITED.

THIS IS UNEVALUATED INFORMATION

25X1

- | No. | Title | Page |
|-----|---|------|
| 1. | Ceramic Method of Gaseous Chromizing Steel | 1 |
| 2. | Resistance to Tempering of Lavers Hard Surfaced by the Electro-
spark Method | 2 |
| 3. | Investigation of the Effect of Subzero Treatment on the
Mechanical Properties of Heat-Treated High Speed Steel | 4 |
1. Title: Ceramic Method of Gaseous Chromizing Steel. Author: G. N. Dubinin.
Published by Vestnik Mashinostroyeniya 33 (1953) No. 12, pp 69/70
- a. Practical. Gaseous methods are the most technically perfected of the
various ways of chromizing steel. The two main variants of the gaseous
method are:
- 1) Combined Method where the chromizing occurs simultaneously and in the
same equipment as the formation of the gaseous chromium-containing
medium.
 - 2) Duplex Method where the chromizing is done with previously prepared
chromium chloride. If the latter salt is not available, a convenient
means of carrying this out is by saturating a ceramic mass with
chromium chloride formed thermally. The second half of the process
consists of heating the parts to the chromized in the impregnated
ceramic. Among the advantage of this method:
 - (a) No special equipment is needed.
 - (b) Impregnated ceramic may be reused if some "new" material is
added each time.

CONFIDENTIAL

SEE LAST PAGE FOR SUBJECT & AREA CODES

DISTRIBUTION	STATE	ARMY	NAVY	AIR	FBI	OSI/C	EV	ATIC	EV
--------------	-------	------	------	-----	-----	-------	----	------	----

This report is for the use within the USA of the Intelligence components of the Departments or
Agencies indicated above. It is not to be transmitted overseas without the concurrence of the
originating office through the Assistant Director of the Office of Collection and Dissemination, CIA.

CONFIDENTIAL

- 2 -

- (c) The ceramic stabilizes the chromium chloride, so it is no longer hygroscopic and therefore is easier to handle.
 - (d) Surface defects such as are encountered with the combined method are absent.
 - (e) A greater saturation of chromium in the chromized layer may be obtained than with the combined method.
- b. This ceramic-pack chromizing (to which most of the paper is devoted) is not new as it is identical with one of the methods described by Becker, Daevs and Steinberg in 1941. Apparently Dubinin is attributing this method either to reference 2 (1945) or reference 7 (1950). All seven references are Soviet. In the USA credit for developing this variation of chromizing is generally given to Becker, Daevs and Steinberg.
- G. Becker, K. Daevs and F. Steinberg: Oberflächenbehandlung von Stahl durch Chromdiffusion. Stahl und Eisen 61 (1941) pp 289/294
- I. R. Kramer and R. H. Hafner: Chromizing of Steel. TATME 154 (1943) pp 415/420; disc 420/422
- c. It is perhaps noteworthy that Dubinin considers gaseous methods the most technically perfected means of chromizing; whereas, in 1950, Minkevich stated chromizing in liquid or gaseous media was nonindustrial although there was a limited commercial use of solid media. It is not clear whether this is a difference of viewpoint or a real commercial development that has taken place between 1950 and 1953.
- A. N. Minkevich: Chemical-Thermal Treatment of Steel. Gosudarstvennoye Nauchno-Tekhnicheskoye Izdatel'stvo Mashinostroitel'noy Literatury. Moscow (1950). 432 pp
- d. This ceramic-pack chromizing differs from the pack-chromizing methods that apparently are the most popular in France, Great Britain and USA today. These various processes have been claimed to be superior to the German methods (and therefore to Dubinin's) although no comprehensive comparison of all these methods seems to have been published.
- T. Bishop: Chromium Diffusion Into Steel. Metal Progress 65 (1954) No. 2, p 112
- P. Galmiche: Steel Protection by Chromium Diffusion. Revue de Metallurgie 47 (1950) pp 192/200
- B. Jousset: The "Onera" Bright Chromizing Process. Metal Progress 60 (1951) No. 4, pp 76/77
- F. C. Kelley: Chromium Impregnation. Metals Handbook (1948) pp 705/706
- C. A. Naugle: Chromizing Process as Developed and Used by Diffusion Alloys, Limited, of London. Technical Data Digest 14 (Nov. 1, 1949) pp 13/19; also Corrosion 6 (1950) No. 11, pp 26/28.
2. Resistance to Tempering of Layers Hard Surfaced by the Electrospark Method. Authors: V.N. Tsvibel, B.A. Krupitskiy and L. N. Balakina. Published by Vestnik Mashinostroeniya 33 (1953) No. 12, pp 75/76
- a. Although electrospark hard surfacing has been widely studied and used, its response to tempering has not been adequately investigated. Annealed carbon steel (0.45% C) was hard surfaced with a variety of materials by means of two different electrospark regimes. Hardness distribution before and after tempering was determined. Both the type of electrode and the electrospark regime affected the results.
- 1) Maximum surface hardness before tempering:
- | Microhardness | Electrode |
|---------------|--|
| 1485 and up | sintered carbide (Ti5K6) |
| 1170 | tungsten |
| 1030 | "Armco iron", carbon steel (0.50% C),
aluminum, ferrochromium |
| 189 * | copper |
- * at some depth below the surface this increased to almost 600 because of precipitation hardening

CONFIDENTIAL

25X1

CONFIDENTIAL

- 3 -

2) Maximum tempering temperature at which surface hardness was unchanged:

<u>Temperature C</u>	<u>Electrode</u>
700	copper
300 to 600 *	sintered carbide, graphite
300 to 400 *	tungsten
300	ferrochromium
200	"Armco iron", carbon steel, aluminum

* depending on electrospark regime

3) Recommended electrodes:

<u>Service temperature C</u>	<u>Electrode</u>
600 to 700	Sintered carbide
400 to 500	ferrochromium, tungsten, graphite
"normal"	"Armco iron", carbon steel

b. The recommended service temperatures for the various types of electrodes would be hard to justify in some cases in view of the actual tests:

- 1) The tempering times were presumably much shorter than service life; therefore, softening would be expected at lower temperatures in service than in the tempering tests. Yet some of the recommendations (for example, ferrochromium) cover temperatures where the deposit showed softening even during tempering and consequently certainly would show more in long-time service.
- 2) Oxidation resistance at the higher service temperatures probably would be a factor. The tempering tests, which were carried out in vacuum, gave no indication of this property.

c. The three previous papers on this subject have apparently pertained to the use of electrospark hard surfacing for cutting tools, where conventional hard surfacing (with an electrode or gas rod) would be difficult. No specific parts are mentioned in the present paper but apparently other types of applications are concerned, since few if any cutting tools would operate at "normal temperatures". For such types of applications there is nothing to prove any advantage of electrospark hard surfacing over other methods.

- 1) To be sure, the deposition by welding of a layer of "Armco iron" would not give surface hardnesses as high as were found with the electrospark method. Similar hardnesses, however, can be obtained in conventional hard surfacing with relatively low-alloy electrodes or rods. Many of the hard-surfacing materials used in the USA have as their major alloying element chromium, which should be readily available in the USSR. It is doubtful, however, whether they conservation of alloys is a vital factor in this particular case in view of the wide use of tungsten and sintered carbide for electrospark hard surfacing.

- 2) There are numerous commercial hard-surfacing electrodes and rods available in the USA for conventional hard surfacing that will give deposits with as good resistance to tempering as that indicated in the present paper for electrospark hard surfacing with the various types of deposits.

d. Except for some types of cutting tools, all of the advantages would seem to be with the conventional hard surfacing as opposed to the electrospark method. First, the latter method requires special equipment not as readily available as electric or gas-welding outfits. Second, the electrospark method is very slow. The present paper indicates that four minutes were required to electrospark hard surface one square centimeter. This time is far longer than would be needed for conventional hard surfacing.

J. Chudoba: Electro-Erosive Metal Removal. Schriftenreihe des Verlages Technik Vol 94. VEB Verlag Technik Berlin (1953) 107 pp

CONFIDENTIAL

25X1

CONFIDENTIAL

- 4 -

V.P. Smirnov: Electrosark Strengthening of Cutting Tools. Avtomobil' naya i Traktornaya Promyshlennost' (1950) No. 12, pp 17/20
I. Yakimchuk: Repeated Reconditioning of Worn Tools. Z. Ekonomiyu Materialov 5 (Dec 1952) pp 72/74

3. Title: Investigation of the Effect of Subzero Treatment on the Mechanical Properties of Heat-Treated High Speed Steel. Author: V. I. Makarova. Published by Vestnik Mashinostroeniya 33 (1953) No. 12, pp 63/66
 - a. Although the metal-working industry needs information on the strength and mechanical properties of high speed steel, little work has been done in this field because of experimental difficulties. A series of bend and torsion tests was made on 18% W - 4% Cr - 0.3% V steel austenitized at two different temperatures and tempered at temperatures from 50 to 650 C. One set was treated at - 78 C and then given a single temper.
 - 1) The change in mechanical properties may be explained by structural changes. The strength is largely but not solely determined by the amount of martensite present. It is believed, however, that unrelieved stresses may lower the strength of steel that has not been tempered or that has been given a low-temperature temper.
 - 2) The subzero treatment significantly increases the plastic properties of high speed steel. For example, in bend tests, steel that had not been so treated fractured brittly; while steel given a subzero treatment ruptured only after plastic deformation.
 - b. Makarova cites no references. A brief review of the literature would have showed that both static torsion and bend tests have been used to a considerable degree in studying high speed steel. Torsion tests have also been applied qualitatively to high speed steel by makers of taps and drills for many years.

A. H. Grobe and G. A. Roberts: The Bend Test for Hardened High Speed Steel. TASM 40 (1948) pp 435/471; disc 471/490
 - c. The general shape of the curves obtained by Makarova is similar to that shown by numerous other investigators. The effect of subzero treatment, however, is open to some question. Gordon and Cohen's results agree with those of Makarova in showing an increase in ductility in steels (18% W - 4% Cr - 1% V) given a subzero treatment. Kennedy, however, in his work on a molybdenum high speed steel (MoMax) found a decrease in some cases.

P. Gordon and M. Cohen: The Transformation of Retained Austenite in High Speed Steel at Subatmospheric Temperatures. TASM 30 (1942) pp 569/588; disc 588/591

R. G. Kennedy Jr: A Study of Subzero Treatments Applied to Molybdenum-Tungsten High Speed Steel. TASM 34 (1945) pp 250/292; disc 292/309
 - d. Makarova's concept of the transformation of high speed steel seems to be rather primitive. Moreover, her data on the amount of retained austenite and of carbides appear to be completely out of line with expectations - both on the basis of USA and Soviet work. This is clear, for example, by a comparison with some of the data given by Kayser and Cohen.

F. Kayser and M. Cohen: Carbides in High Speed Steel - Their Nature and Quantity. Metal Progress 61 (1952) No. 6, pp 79/85
 - e. The steel investigated by Makarova is rather interesting. In the first place, it indicates there is still some use of the 18% W type despite all the Soviet work on low-alloy and molybdenum high speed steels. The vanadium content is rather difficult to explain. Such low vanadium contents have not been used for cutting tools for at least 40 years. On the other hand, the carbon content seems too high for hot-work applications.

25X1

25X1

CONFIDENTIAL

25X1